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TECHNICAL SUPPORT DOCUMENT

Study Plan - A Monitoring Program to Evaluate Polychlorinated
Biphenyls (PCBs) in Fish and Sediments of Lake Hartwell, South Carolina

Prepared by
Water Quality Monitoring Section

1986

South Carolina Department of Health and Environmental Control
Office of Environmental Quality Control
Bureau of Water Pollution Control
Division of Water Quality Assessment and Enforcement



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I. INTRODUCTION

The purpose of this document is to lend support to the 1986 update in the Lake Hartwell PCB monitoring program. The new Study Plan was prepared because of recent developments which showed that the original study plan was no longer applicable to meet the informational needs of SCDHEC. For example: (1) a thorough examination of existing data (1977-1985) revealed weaknesses in the data base for meaningful trend evaluations; (2) the new FDA action level indicated that new areas of the lake needed to be sampled; and, (3) a thorough examination of the data indicated that with more detailed sampling, certain species could perhaps be taken from under advisement.

The following components discuss the rationale behind the development of the new Study Plan. The same format as appeared in the Study Plan is used here to facilitate easy reference to the Study Plan.

II. STUDY OBJECTIVES

The study objectives are basically the same as in the original study plan except that greater emphasis is being placed on the critical evaluation of the data for those small weight class (SWC) fish in the advisory area which apparently have acceptable PCB levels (<2.0 ppm). This will be discussed in greater detail in Section IV.C.

III. STUDY AREA

The original study plan called for monitoring six station locations throughout Lake Hartwell: two stations in the Tugaloo River arm; two stations in the Seneca River arm; and, two stations in open water. By 1985, however, all except the two Seneca River stations had been discontinued. This was primarily due to budgetary constraints and because the fish being monitored at stations outside of the Seneca River arm had

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acceptable PCB levels (<5.0 ppm).

In consideration of the new FDA 2.0 ppm action level, it has become necessary again to include the entire lake for monitoring. It is presently unknown to what degree larger fish may be contaminated with PCBs above 2.0 ppm in areas not under advisory. The five stations selected for monitoring were chosen to be representative of all of Lake Hartwell (Figure 1).

It should be noted that because of the uncertainty factor concerning the new 2.0 ppm FDA action level, SCDHEC advised the public in a 1984 news release not to eat any fish larger than three pounds taken from anywhere in Lake Hartwell below the S.C. Highway 24 bridge. This was done as a precautionary measure until the areas not covered by the advisory could be properly evaluated. The three pound limit was established because it is the lowest weight class fish, based on past Lake Hartwell PCB data, that have less than 2.0 ppm PCBs in areas below the advisory boundary.

The longstanding advisory to the public had been not to consume any extremely large fish taken from below S.C. Highway 24, but until now it had been without a size specification. The rationale for avoiding large fish is that larger fish, hence older fish, may accumulate higher levels of PCBs than smaller, younger fish due to longer exposure risk.

IV. SAMPLING STRATEGY

Fish

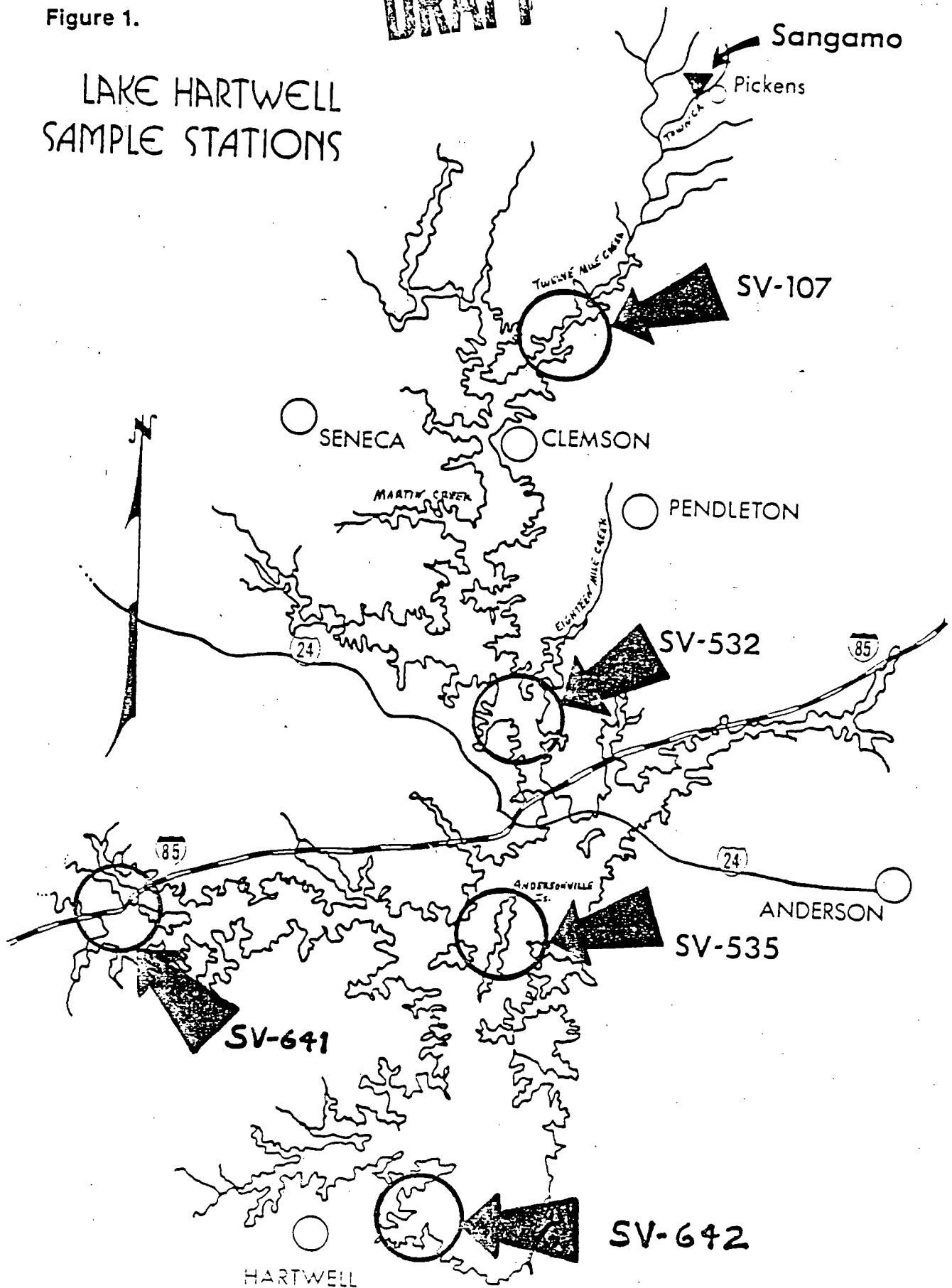
A. Sample Species

The species chosen for monitoring were selected to be as representative as possible of all the fish types in Lake Hartwell. Additionally, fish that have seasonal distribution patterns and feeding

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Figure 1.

LAKE HARTWELL SAMPLE STATIONS



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habits that may affect the levels of PCB contamination were also considered. Equally important was to select species which are valued game fish and most likely to be caught and eaten by the public. This is a very important factor to consider in public health risk assessments.

Crappie, largemouth bass, and hybrids are very important game fish to the public. They represented nearly 40, 24, and 23 percent, respectively, of the 1982 harvest in Lake Hartwell (SCWMRD, 1983). Not only is the hybrid a valued game fish, it also represents a migratory species that moves in and out of contaminated areas of Lake Hartwell. Therefore, PCB concentrations of hybrids should represent a worse case situation for fish in areas of the lake not under advisory.

The channel/white catfish (non-game species), due to their association with the lake bottom, should represent a worse case situation for fish in areas where there is high sediment contamination. Due to their bottom feeding habits, it is suspected that channel/white catfish ingest large amounts of PCB-contaminated sediments. White catfish have shown higher PCB body burdens than largemouth bass collected from SV-107, an area with highly contaminated sediments (SCDHEC, 1982).

B. Sampling Frequency

The overriding factor for conducting annual sampling during spring is because this is when sampling will be most successful for the total numbers of species and specimens needed in the right size class. It is vital that the total numbers of species and specimens in the correct size class as clearly specified in the Study Plan be

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collected from each station, each year to permit valid comparisons of the data using statistics. It is only through sound statistical analysis of the data that the objectives of the study can be met and confidence be assigned to the numbers that are generated.

It is recognized, however, that the analysis of PCBs from some species of fish during the spring may be an underestimate of the maximum PCB tissue values which could occur during late fall or early winter. This is because some PCBs appear to be translocated from the body muscle tissue to the viscera (liver, gonads, eggs, etc.) of the fish as it undergoes the stresses of spawning due to increased energy requirements during spring and summer (Vernberg, 1977; White, 1985; Kellogg, 1976; Veith, 1975). This is the reason that percent lipid content will be measured for all fish. Also, to test whether or not this seasonal difference occurs to any significant degree in Lake Hartwell, repeat sampling will be conducted at Station SV-532 during late fall of 1986. SV-532 was selected because it is just above the present advisory boundary and is the most likely area where future revisions may first occur in the advisory, if necessary.

C Sample Weight Classes and Numbers

1. Sample Weight Classes

The weight classes were selected in order to provide information on a much wider range of fisheries in Lake Hartwell than had been previously provided. The primary benefit from such a sampling scheme is that it will place SCDHEC in a better position of not having to be overly conservative in its public health advisories thereby safely allowing greater public utilization of Lake Hartwell's fisheries.

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In previous studies, sampling was oriented toward two to three year size-class fish; that is, those just entering the harvestable size-class. The greatest utility from this type of sampling was that it enabled SCDHEC to determine whether or not the PCB levels in fish from Lake Hartwell were increasing or decreasing as a result of measures taken to eliminate the primary source of PCBs to the lake. An analysis of the two to three year size-class fish has indicated a downward trend in PCB contamination (USEPA, 1982; SCDHEC, 1982).

A major weakness in keying on the two to three year size-class exclusively is that it provides no information on the population of larger fish, which theoretically could have higher PCB levels. Consequently, SCDHEC had to take the conservative approach and advise the public in general terms not to eat large fish from areas not under advisory. It also caused SCDHEC to refrain from lifting the advisory in areas where the two to three year size-class fish had acceptable PCB values for the lack of information on larger size-class fish.

The new Study Plan calls for collecting the largest practical size-class fish (to be measured by weight and not length) which can be successfully collected in the specified required numbers each year at each station. When these fish have acceptable PCB levels, it can be safely assumed that smaller weight class fish of the same species will also have acceptable PCB levels. In effect, this means that a larger segment of the Lake Hartwell fisheries can be made available for public harvesting through safe revisions of the advisory.

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The weight classes were selected based on prior field experience from 1977 to 1985, which suggested that those weight classes could be successfully collected each year without an unreasonable resource commitment to the sampling effort. In the event the selected weight classes prove to be uncollectable during 1986, the next highest weight class will be selected that can be successfully collected each year.

The small weight class (SWC) fish will be sampled at a particular station whenever it is determined that the large weight class (LWC) fish of the same species at that station have unacceptable PCB levels (≥ 2.0 ppm). If the larger fish are unacceptable (≥ 2.0 ppm), it does not necessarily mean that SWC fish will be too.

The SWC fish were selected to correspond with the most frequently harvested weight class fish in Lake Hartwell according to the latest creel census information for that lake (SCWMRD, 1983). The 1982 census showed that nearly 87 percent of the harvest was composed of the five species to be sampled during this study.

There are two basic advantages for looking at the SWC fish. First, since these fish are the most frequently caught and presumably eaten by the public, much more meaningful public health risk assessments can be made by SCDHEC. Secondly, the public will benefit not only from the public health risk assessments, but also by being able to fish new areas that may be taken from under advisory.

The limits of the SWC fish in this study are based on the mean weight class fish harvested. Ideally, the mode of the weight class for each species should be used instead of the average, for it would represent the single most frequently caught weight class. However, the mode can not be determined from the 1982 creel census data because individual fish were not weighed to determine the mean weight. Instead, all species in each boat were weighed together and an average weight was then calculated (Williams, personal communication). Therefore, the SWC fish to be collected in this study will have weight ranges targeted to represent the mean weight class fish harvested in Lake Hartwell according to the 1982 creel census: (1) largemouth bass - 1.98 lbs; (2) hybrids - 2.36 lbs; (3) all catfish - 0.82 lbs; and (4) crappie - 0.46 lbs.

A decision matrix will govern when to start the SWC fish sampling phase (Figure 2). For instance, when any one of the three LWC fish have unacceptable PCB values (≥ 2.0 ppm), the SWC fish sampling phase for that particular species will be implemented. It will continue until that particular larger species in the LWC fish sampling phase has acceptable PCB levels (< 2.0 ppm).

2. Sample Numbers

The total number of specimens of each species needed during this study to allow for valid statistical comparisons of the data was determined by using the following formula (Cohen, 1977):

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$$F = \frac{\sigma_m}{\sigma} \quad \text{Where } \sigma_m = \sqrt{\frac{\sum_{i=1}^k (m_i - m)^2}{k}}$$

m_i = mean at each station

m = overall mean

k = number of sites

σ = overall standard deviation

σ_m = standard deviation at each site

Power value = 0.80

α = 0.05

n was determined using sample size charts from Cohen, 1977, p. 384.

The 1983 to 1985 Lake Hartwell PCB fish tissue data were used to generate the necessary variances and means for determining the sample sizes for each species. The following numbers of specimens for each species was calculated using the above formula (all data used and calculations are available upon request): (1) hybrids - 10; (2) largemouth bass - 10; and, (3) channel/white catfish - 4.

The channel/white catfish are being mixed for PCB analysis for several reasons. Since prior data from both species were combined and analyzed to determine a sample size needed for the study, it would be inappropriate to select out one of the two without first knowing the true variability associated with each. Furthermore, even if and when it may be determined that either the channel or the white catfish may become the species of choice, sampling experience has shown that it would be very difficult to collect either species in sufficient numbers in the desired weight class at all station locations. The channel catfish are more readily collected at the riverine stations; whereas, the white

catfish are more readily collected at the open water stations. With reasonable sampling effort it is expected that two channel and two white catfish in the desired weight class can be collected from each of the five sampling locations.

Since all five stations will be compared to each other with equal combinations of channel and white catfish, any variability which may exist in PCB body burdens between the two species would have no effect on the station to station comparisons. In addition, better public health risk assessments may be made as a result of the combination analysis because it is suspected that both catfish species are being equally consumed by the public.

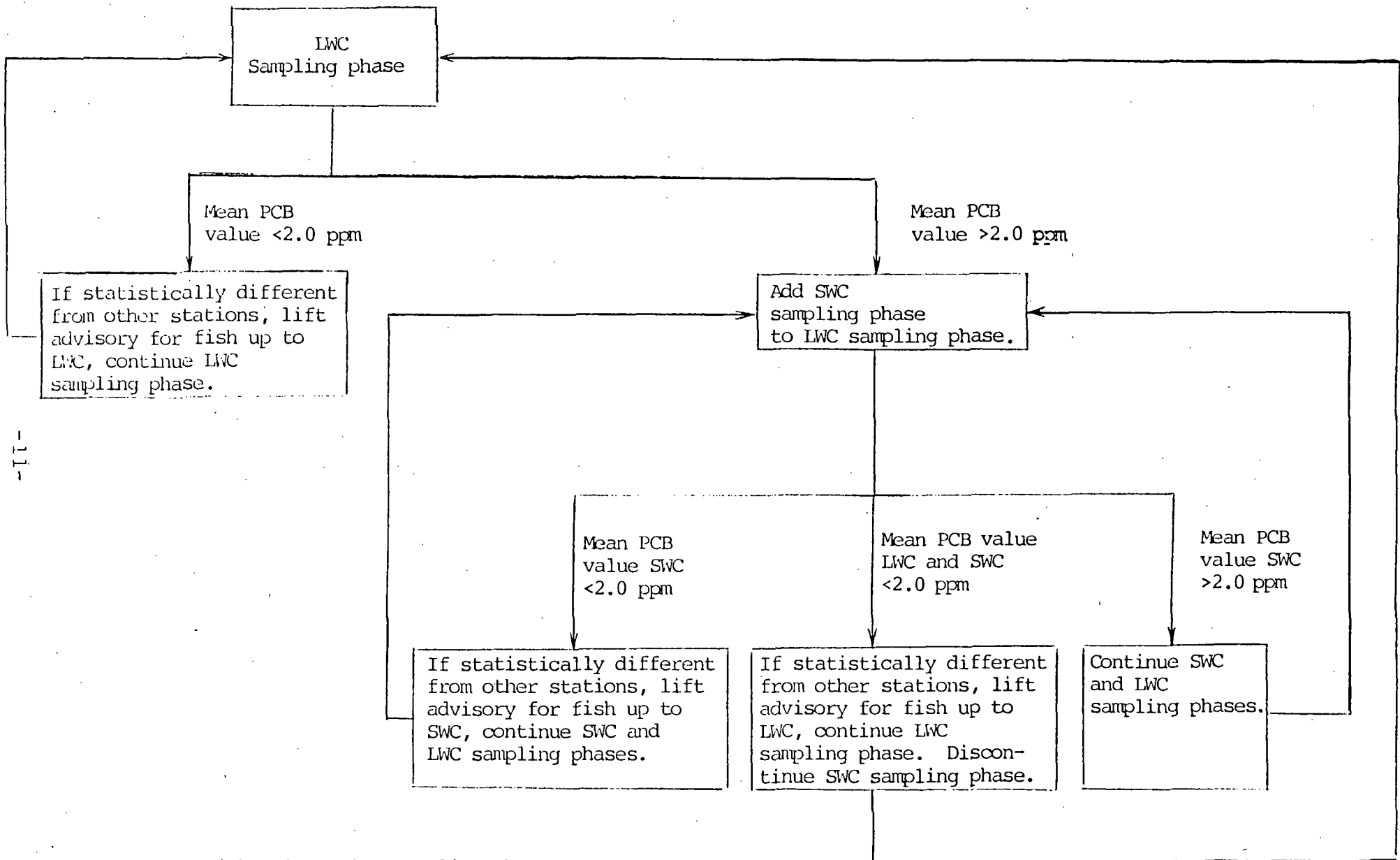
Sediments

Since there appears to be some down-lake movement of PCBs in the sediments from the upper reaches of Twelve Mile Creek, sediments will be collected annually for total PCBs analyses from each station.

The PCB sediment data collected thus far by both SCDHEC and EPA show no definite trend, but the data do show that concentrations in certain areas of the lake are very patchy. It is suspected that this patchiness occurs because the PCBs associated with the fine silts tend to follow the river channel until they settle out. This was apparent during recent sediment sampling for total PCBs analyses (USEPA, 1985). In seven discreet samples, collected in an area of Twelve Mile Creek that covered approximately 0.25 mile, total PCB values ranged from 1.38 to 43.0 ppm. A closer look at the seven stations showed that when two adjacent stations (approximately 200 feet apart, one in the river channel (Station 1) and the other outside the channel (Station 10)) were compared, they had total PCB

Decision Matrix - Monitoring Program to
Evaluate the Levels of Polychlorinated Biphenyls (PCBs)
in Fish and Sediments of Lake Hartwell, South Carolina

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LWC = Large Weight Class Fish Sampling Phase

SWC = Small Weight Class Fish Sampling Phase

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values of 31.6 and 5.6 ppm, respectively. This also occurred at stations 9 (outside channel) and 3 (inside channel) where there were concentrations of 1.38 and 25.0 ppm, respectively.

Therefore, sediment sampling for total PCB analyses in Lake Hartwell will be oriented toward collecting samples from center channel with the aid of an electronic depth finder. During the 1986 sediment sampling the stations will be fully described so that subsequent sampling can be conducted as closely as possible to previous samples.

V. SAMPLE HANDLING

The change to be implemented in the Study Plan of utilizing whole fish analysis (minus the head and viscera) instead of fillets is designed to minimize the degree of variability in PCB tissue levels which may be caused by preparation of fish for analysis. Past data have shown a high degree of variability in PCB tissue levels in both individuals and composites of same size/species taken from identical locations. To illustrate this high degree of variability, below are data taken from fillets of largemouth bass collected from Twelve Mile Creek in 1979:

| <u>Species</u> | <u>Length (mm)</u> | <u>Weight (g)</u> | <u>PCBs (1254) ppm</u> |
|-----------------|--------------------|-------------------|------------------------|
| Largemouth bass | 330 | 440 | 2.78 |
| " | 330 | 440 | 17.82 |
| " | 335 | 450 | 12.12 |
| " | 330 | 455 | 2.63 |
| " | 355 | 660 | 6.20 |
| " | 365 | 695 | 18.90 |
| " | 380 | 810 | 3.12 |
| " | 400 | 910 | .83 |

Although natural variation is expected due to a multitude of physico-chemical and biological factors, it is suspected that the filleting technique used to prepare these fish played a major part in the variability

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of the data. The filleting method previously used by SCDHEC unpredictably removed from or left fatty tissue with the remainder of the fish carcass. Since PCBs are highly lipophilic, this could be responsible for some of the variability. White (1985) found a statistically significant difference in PCB levels in fish whose fillets had been trimmed of fatty tissue when compared with standard fillets. Also, he found that the mean lipid content for the standard fillets was 6.9 ± 2.3 percent of wet weight compared to 3.8 ± 1.2 percent for trimmed fillets. Since different people prepare fish differently, this new cleaning procedure would be most conservative from a public health risk perspective. However, it should be noted that because of this new cleaning procedure, whereby more fish tissue will be analyzed, overall higher PCB values are expected to occur in all fish from all station locations during 1986 than occurred in recent years.

Percent lipid content data will be used to help evaluate the natural variability via co-variant/regression/ANOVA analysis. For example, post-spawning fish collected during spring would be expected to have less fat and PCBs in body tissue compared with prespawning fish collected during late fall (Vernberg, 1977; Kellogg, 1976; Veith, 1975).

VI. SAMPLE ALLOCATION

No comment necessary.

VII. DATA ANALYSIS

Now that the FDA action level for PCBs in fish tissue is 2.0 ppm as compared to the previous action level of 5.0 ppm, it is possible that the longstanding fish consumption advisory in Lake Hartwell for certain species may have to be revised. The new Lake Hartwell Study Plan was designed for this eventuality.

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The Study Plan calls for sampling four species (largemouth bass, hybrid bass, and channel/white catfish) at five sites on the lake. Also, crappie will be sampled as previously discussed. The objectives are two-fold:

1. To obtain a mean total PCBs concentration at each site for different species in a pre-determined weight-class with a 95 percent confidence interval.
2. To compare the means between sites for significant differences.

The second objective is extremely important in this study because the advisory boundary line is to be shifted according to the mean results. Should a station within the advisory prove to be statistically equal to a station outside the advisory, then the advisory boundary line would have to be shifted to include the outside station, even if its mean total PCB concentrations are below the 2.0 ppm level.

The sample sizes (see Section IV.C.2.) were selected on the basis of comparing five means at one time. The null hypothesis will state that the means are equal (all ≥ 2.0 ppm). Power will be set at 0.80 which will make the mistaken rejection of the null hypothesis (Type I error) four times as serious as mistaken acceptance (Type II error). Since a site can only be excluded from the advisory when it is proven to be significantly different than the other sites by hypothesis testing, this power level will be conservative on the side of public health concerns.

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